

Sandia National Laboratories Laboratory Directed Research and Development

We welcome your questions, comments, and ideas for future LDRD projects to feature! Email your feedback to Marie Arrowsmith, mdarrow@sandia.gov

Hybrid Scintillators for Neutron Discrimination

Joseph Cordaro (PI), Mitchell Anstey, Patrick Feng, Alfredo Morales

Sandia researchers were awarded a patent for a class of hybrid scintillators for neutron discrimination, capable of scalable, stable, and low-cost detection of neutron radiation from nuclear threat materials.

Federal agencies continuously seek new radiation detection technologies to detect the movement of special nuclear materials and for arms control and treaty verification. Based on an LDRD project entitled *Improved Pulse Shape Discrimination in a Multicomponent Water/Organic System*, ending FY13-15, Sandia researchers were awarded a patent for a class of hybrid liquid/gel scintillators capable of efficient detection of neutron radiation from nuclear threat materials. Scintillators have proven very useful in the differentiation of the unique radiation emitted by ionizing particles. When electrons and ions recombine in a luminescent material such as a scintillator, a technique called pulse-shape discrimination may be used to differentiate the various responses of the particles. However, standard formulations for liquid scintillators have storage and toxicity concerns; designs based on less flammable solvents possess similar storage constraints and exhibit decreased performance in large-scale applications. Sandia's hybrid scintillators allow for flexibility in their designs, and consist of key materials that create a scintillator that is stable, low-cost, and scalable to large sizes. Read more by searching for US Patent No. 9029807.

Awards & Recognition for LDRD participants

Sandia's **Twistact technology**, developed through LDRD (PI: Jeff Koplow), recieved an **Outstanding Technology Development Award** from the Federal Laboratory Consortium. **Decontamination Technology for Chemical and Biological Agents**, rooted in several LDRDs headed by PI Mark Tucker, received an **Excellence in Technology Transfer Award** from the Federal Laboratory Consortium.

The Journal of Materials Science publication describing LDRD, *Instrument for Stable High Temperature Seebeck Coefficient and Resistivity Measurements under Controlled Oxygen Partial Pressure*, was selected as a **finalist for the 2015 Cahn prize**. Pls include H.J. Brown-Shaklee, P. A. Sharma, and J. F. Ihlefeld.

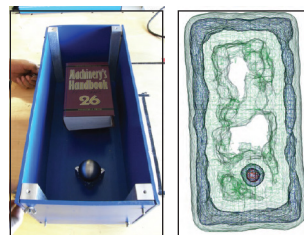
Underground Imaging Using Muons

Nedra Bonal (PI), Leiph Preston, Daniel Dorsey, David Schwellenback, Wendi Dressen, and Andrew Green

A new LDRD-developed method uses back-scattered muons—atmospheric subatomic particles—to locate and characterize underground structures by imaging subsurface density variations.

Locating and characterizing underground engineered structures such as tunnels and caverns are important to areas such as energy surety, nonproliferation, and border and facility security. Typical characterization methods like sonar, seismic, and ground penetrating radar have shown mixed success, as they are not particularly sensitive to the density variations resulting from structural voids. Sandia researchers are investigating the use of muons, subatomic particles generated in the upper atmosphere and capable of penetrating the earth's crust several kilometers, to resolve underground features such as tunnels and concealed objects.

Currently, muon tomography can resolve features to the sub-meter scale. However, the muon detector must be placed below the target of interest, which is costly and impractical in many locations. This LDRD focuses on using upward traveling muons, which result from back scattering, to eliminate the constraint of positioning the detector below the target. Several early experiments indicate the promise of the method: (1) muons collected through a lead box containing high and low density were used to image concealed targets of various densities; (2) muon data collected inside X-Tunnel at the Nevada Nuclear Security Site was used to image a vertical shaft and estimate tunnel overburden; and (3) several rocks of different types and densities were imaged to constrain the density resolution of this technology.



Muons can be used to image objects concealed in lead (blue box shown without top cover, left), which is a benefit over x-rays. Also, muons can image low density (book) and high density (tungsten sphere) objects.

LDRD PROJECTED BUDGET AND STATUS

FY15 Q4 \$149 MILLION 380 PROJECTS FUNDED AT \$145.2 MILLION

UPCOMING LDRD EVENTS

Sept 9 - Nano-micro ending project reviews
Sept 10, 17 - DS&A ending project reviews
Sept 15-16, 29-30 - Biosciences project reviews
Sept 17 - Eergy & Climate ending project reviews
Sept 21 - Engineering Sciences ending project reviews

Digital Holography for Quantification of Fragment Size and Velocity from High Weber Number Impacts

Dan Guildenbecher (PI), Phillip Reu, Jun Chen (Purdue), Jian Gao (Purdue)

An LDRD-developed technology based on digital in-line holography provides a rapid and robust method for predicting the behavior of burning droplets of fuel.

Large transportation accidents can create catastrophic fires, as tanks containing flammable or hazardous liquids impact surfaces at high velocity. Understanding how burning droplets of fuel are generated and behave in these types of events is critical to hazard prediction and mitigation and applicable to many governmental agency missions. Historical techniques used to characterize droplet dispersion, based on phase-Doppler anemometry, were spatially limited and provided information only in a two-dimensional plane. Sandia researchers have developed three-dimensional (3D) measurement techniques based on digital in-line holography (DIH) that automatically extract 3D particle position and morphology.

DIH is a laser-based optical technique used to measure particle sizes and three-dimensional positions and velocities. The team significantly advanced the technique, particularly for diagnostics of high-velocity droplet fields by (1) using nanosecond laser pulses to improve temporal resolution, (2) developing advanced algorithms to detect individual droplets and track them through multiple exposures, and (3) applying tomographic methods to improve the out-of-plane resolution of large-scale flow fields. Results show that the accuracy of the particle positions measured using the newly developed algorithms was improved by an order of magnitude compared to previous literature results.

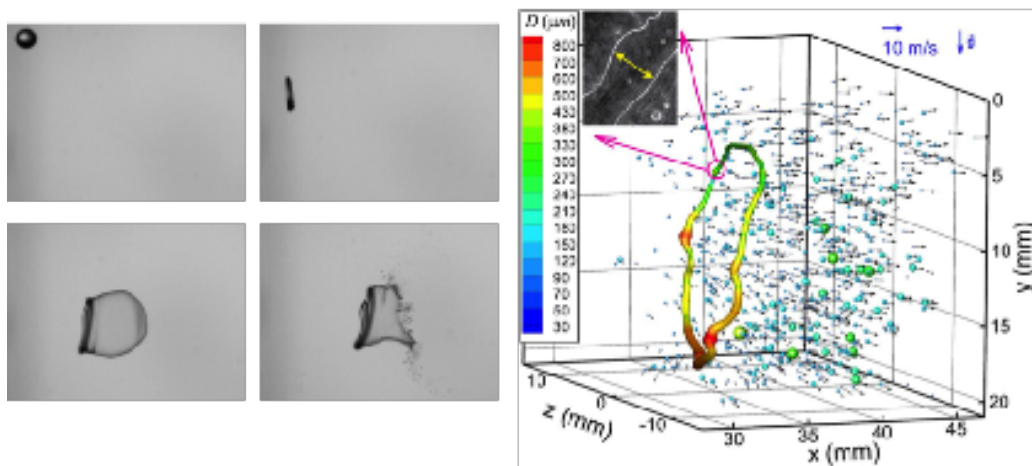


Figure 1. Typical white light recording of the breakup of an ethanol drop in an air stream (left) along with the 3D DIH results (right); from Gao et al. (2013).

In addition to measuring fuel breakup at high velocities (Figure 1), this LDRD-developed technology has been applied to other challenging 3D phenomena, such as particles in environments containing shock waves and aluminum drops from propellant fires. An ongoing LDRD project will extend the technique to quantify the breakup of molten components in shock-induced flows.

READ MORE:

Gao, J., Guildenbecher, D. R., Reu, P. L., Kulkarni, V., Sojka, P. E., and Chen, J., 2013, *Quantitative, 3D diagnostics of multiphase drop fragmentation via digital in-line holography*, Opt. Lett., 38(11), pp. 1893-1895.

UPCOMING LDRD EVENTS

MAY 26 – JUNE 16

Technical and Programmatic Proposal Reviews

JUNE 17 – JUNE 30

Proposal Reviews by Investment Area Representatives

LDRD PROJECTED BUDGET AND STATUS

FY15 Q3 \$146 MILLION 373 PROJECTS FUNDED AT \$140.5 MILLION

AWARDS & RECOGNITION for LDRD Participants

Mark Taylor received the highest non-monetary award from the U.S. Department of Energy—the 2014 Secretary's Honor Award—for his work as chief computational scientist for DOE's Accelerated Climate Modeling for Energy executive council team.

Aleksandra Faust was awarded the 2015 Tome L. Popejoy Dissertation Prize by the University of New Mexico for her work in robotics. This award recognizes the highest levels of excellence among doctoral students.